Florida Atlantic University
Department of Ocean and Mechanical Engineering

Presents

Modulation of a Bio-inspired Micro-Surface on the Flow Evolution of a Wind Turbine Blade

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Engineering Chair in Wind Energy, & Professor
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2 to 3 p.m.
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FAU Boca Raton Campus

Abstract

Surface roughness can result from mosquitoes and other debris that are impacted on the surface of wind turbine blades, creating a layer of random roughness. This is known to negatively impact the performance of wind turbines, increasing form drag by moving the separation point toward the leading edge, thus increasing the external loads that negatively affect the drive-train and energy production. In this seminar, we will discuss how a bio-inspired micro-scale surface of a mushroom type that modulates the flow dynamics of a wind turbine airfoil. Our experimental results from an index-matched facility provide evidence that this bio-inspired surface does not produce additional turbulence as normally encountered on rough surfaces. By employing this micro-scale surface on an airfoil (see figure below), we showed that drag is mitigated and the separation point moved toward the trailing edge. Although this bio-inspired surface modulates the flow evolution, the behavior of the flow is quite opposite to the typical surface roughness. Moreover, the theory developed by Castillo and collaborators in the early 2000's using the equations of motion suggest that the flow, although separated, remains in equilibrium. The mechanism by which the flow dynamics changes and reduces separation is due to injection and blowing along the surfaces, producing regions of high speed along the surface. Consequently, the bio-inspired surface produces an effective slip velocity near the wall region contrary to surface roughness. Besides wind energy applications, this unique surface offers benefits of drag reduction for hydrodynamic bodies, airplanes, trans-continental pipes and cars. Furthermore, there is evidence that similar surfaces possess self-cleaning properties, and the micro-pillar coating works on water under wet conditions.

Biography

Prior to joining Texas Tech University in 2011 as the inaugural Center Director of the National Wind Resource Center and Don Kay Clay Cash Distinguished Engineering Chair in Wind Energy, he was Professor at Rensselaer Polytechnic Institute in the Mechanical & Aerospace Department. His areas of research interests include: turbulence, renewable energy and bioengineering. He has published over 100 publications, edited several books on renewable energy and co-authored several patents (e.g., energy, health care, etc.). Some of his awards include: Fellow ASME, the NASA Faculty Fellowship, the Martin Luther King Faculty Award, the Robert T. Knapp Best Paper Award from the ASME, the Best Paper Award from the Journal of Renewable Energy, the Best Paper Award from IEEE, and the Rensselaer Faculty Award (twice). He gave several keynote lectures, plenary lecture, and distinguished lectures on wind energy. Currently, he serves as Associate Editor of Wind Engineering & Science, and serves in various scientific committees on renewable energy in Europe. He is passionate about inclusiveness and mentoring students and young faculty, and founded and organized two summer research institutes on renewable energy and medicine, which included students, faculty and K-12 teachers. For his contributions and impacts on inclusiveness he received the 2016 McDonald Mentoring Award from the ASME, and was nominated for a Presidential Award given by the President of the United States.

For more information please send email to ome@fau.edu.

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